Mapping Clinical Scenarios To Functional Requirements: A Tool for Evaluating Clinical Information Systems

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We developed a tool for evaluating clinical information systems (CIS) by mapping a set of detailed functional requirements to specific elements of clinical scenarios. A team of primary care physicians, specialists, medical records professionals, and information systems staff defined detailed requirements for a new CIS at Harvard Pilgrim Health Care. The requirements were mapped to elements of clinical scenarios, which were provided to vendors for use in demonstrating their systems. Systems were rated as to how well they met the functional requirements in their demonstrations. This method of evaluating information systems provides an incremental advantage over use of requirements or scenarios by themselves.

INTRODUCTION

Choosing a clinical information system (CIS) requires making direct comparisons among available systems and identifying which one best meets organization needs. Traditionally, comparisons are based on vendor demonstrations and responses to a detailed request for proposal (RFP).

Establishing explicit clinical requirements and evaluating how effectively a system will support those requirements will increase the likelihood of clinician acceptance and therefore, the likelihood of a successful implementation. Abendroth and Tang have previously described establishing needs-based requirements for designing and evaluating systems.[1,2,3,4]

Use of clinical scenarios to design and evaluate information systems is becoming increasingly widespread.[5] Mapping individual system requirements to elements of scenarios can provide the basis for evaluating information systems, directly comparing them based on objective criteria, and ensuring that the chosen system will meet the needs of the clinician users.

In this paper, we will describe our approach of explicitly mapping core clinical requirements for a new CIS to elements of custom-developed clinical scenarios and the use of these scenarios to evaluate and choose among several candidate systems.

METHODS

Site

Harvard Pilgrim Health Care, the largest health maintenance organization (HMO) in New England, with over 1,000,000 members, consists of 19 staff-model health centers, as well as many group practices. Thirteen health centers have used a COSTAR-based automated medical record system (AMRS) for over twenty years to document approximately 2,000,000 encounters annually.[6] Clinicians complete paper Encounter Forms documenting visits, prescriptions, lab orders, and referrals. Medical records staff enter this information into AMRS. The group practices use paper-based medical records.

Selection of new CIS

Harvard Pilgrim plans to purchase and implement an organization-wide electronic medical record system throughout the health centers and medical groups. The selected system will need to support the health center clinicians accustomed to a significant degree of online information via AMRS as well as the medical group clinicians accustomed to working without information system support.

Evaluation team

An evaluation and selection team, comprised of primary care providers and specialists, medical records professionals and information systems staff, was appointed to evaluate candidate systems and recommend a CIS for implementation.

System requirements

A requirements document was developed based on:

- interviews with representatives from 40 specialties.
- Harvard Pilgrim's experience with AMRS
- Harvard Pilgrim's experience with two prior CIS development projects

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Using these experiences, the selection team developed a set of *core functions*, broad categories for the functions the new CIS would have to perform. (Figure 1)

Figure 1.. Core functions identified by selection team

1.0	**Clinician Documentation**	
	1.1	History and Physical Information
	1.2	Risk Factors
	1.3	Allergy Information
	1.4	Vital Sign Information
	1.5	Immunizations
	1.6	Problems
	1.7	Office Procedures/Office Tests
	1.8	Follow-up Instructions
	1.9	Telephone Interactions
	1.10	Informed Consent
	1.11	Evaluation Management (Level of Service)
2.0	**Order Management**	
	2.1	Order Entry
	2.2	Order edits and cancels
	2.3	Order status updates
	2.4	Prescription-specific capabilities
	2.5	Immunizations
3.0	**Results Reporting**	
	3.1	Storage and on-line results retrieval
	3.2	Flowcharting
4.0	**Referral Management**	
	4.1	Orders
	4.2	Consult reports
5.0	**Decision Support**	
	5.1	Reminders
	5.2	On-line rules and protocols
6.0	**Clinician entry options**	
	6.1	Directly through GUI
	6.2	Paper form input by support staff
	6.3	Dictation
7.0	**Patient Information Retrieval**	
	7.1	Flowcharting
	7.2	Problem and Medication List
	7.3	Configurable Patient Record
8.0	**Correspondence**	
9.0	**Coded Data**	
	9.1	User configurable terminology
	9.2	Ability to link to industry standards
10.0	**Medical Record Room Functions**	
	10.1	Standard Reports
	10.2	Transcription

Detailed system requirements were explicated for each core function. An example of the detailed requirements for the core function *Immunizations* is shown in Figure 2.

Figure 2. Example of System requirements for Immunizations

- *Ability to document immunizations in the patient record.*
- *Allow the clinician to document previous immunizations (historical).*
- *Ability to record adverse reactions to an immunization.*
- *Ability to record a vaccine was administered by someone other than the encounter physician.*
- *Allow the clinician to document the manufacturer's name and lot number of the vaccine administered.*

Another type of system requirement, *attributes,* was also defined. Attributes are universal qualities, not directly related to core functions, which may affect clinical and non-clinical use of the CIS. (Figure 3)

Figure 3. Examples of system attributes

ATTRIBUTE	EXAMPLE
User Interface/ Ease of Use	Screen labels are clear and concise
Flexibility	Ability to add a new data field
End user customizations	User customized built-in reminders or ticklers
Seamlessness	Support access to other desktop tools
Data Timeliness	Batch patient information by clinician session for review before the start of a session
Security and Confidentiality	Support flexible rules for secure encounters
Accessibility	Multiple user simultaneous access
Clinical Teamwork	Supports "forwarding" electronic notifications to covering team when needed

The Evaluation Team identified a total of 750 specific requirements, both core functions and attributes, for the new CIS. Team members rated each requirement as *Required, Highly Desirable,* or *Would Be Nice.* Eighty percent of the requirements were identified by at least one clinician as being required in the CIS.

Clinical scenarios

Clinical scenarios were created and provided to vendors to be used as the basis for demonstrating their systems. Two scenarios were written-- one for adult internal medicine and another for pediatrics-- to evaluate how well the CIS supported the workflow of primary care physicians.

Internal Medicine scenario. The internal medicine scenario described a typical primary care encounter, but also included: interruption of a patient visit by an emergency telephone call, communication between a physician and ancillary staff, accommodation of the special security needs of a VIP patient, as well as ordering and retrieval of laboratory test results. In addition, the scenario offered the opportunity to demonstrate online ECG display, Soundex functions, alerts for overdue health maintenance protocols, and support for clinical algorithms. The following is an excerpt from the internal medicine scenario:

A 60 year old woman, Mrs. M, comes in for a scheduled appointment. Mrs. M confirms her visit with the medical assistant at the front desk. Dr. S has been Mrs. M's primary care physician for several years. The health center at which Dr. S practices is Mrs. M's primary health center. Mrs. M is a health center employee; therefore, the medical assistant can input data, but cannot access Mrs. M's medical record. Mrs. M is brought into an exam room by the medical assistant who takes her vital signs and records them in an online medical record.

While Mrs. M is waiting, Dr. S arrives at her office and logs into the clinical information system. Dr. S has a list of unread patient reminders, lab results, and other messages. Dr. S views a reminder that a note she dictated yesterday needs to be reviewed and signed. Another message tells her that one of her patients was seen in Urgent Care last night.

Pediatric medicine scenario. The pediatric scenario described a scheduled well child visit. The ability of the CIS to alert the clinician to provide necessary immunizations, as well to alert for drug allergies was assessed. Online presentation of peak flow measurements and growth chart data, as well as the ability to input diagrams and pictures into the medical record were also included in the scenario. The following is an excerpt from the pediatric scenario:

A three year old boy, Chris, comes in for a well child visit. When the pediatrician, Dr. P, reviews the patient's record, an alert for a DPT immunization flags the online record. The pediatrician asks the nurse to administer the vaccine and document it in the record.

The patient also has a rash, which the pediatrician adds as an active problem to the patient's problem list. Dr. P assigns a principle diagnosis of atopic dermatitis and indicates the location of the rash in the record. Dr. P refers the patient to a dermatologist to confirm this diagnosis.

RESULTS

Mapping system requirements to clinical scenarios

Each system requirement was mapped to a specific element in the clinical scenarios. Together, the two scenarios covered 50% of the requirements rated as high priority (i.e. required or highly desirable) in the requirements document. The remaining requirements were not directly addressed in the scenarios. An excerpt of the tool that resulted from mapping requirements to scenario elements is shown in Figure 4.

Figure 4. Excerpt from evaluation tool: mapping functional requirements to clinical scenario events

REQUIREMENTS	SCORE	SCENARIO EVENT
Allow user to easily retrieve an active problem list.		*Dr. S scrolls through record looking at Problem List.*
Allow encounters to be retrieved by: specialty, delivery site, provider, and date range.		*Dr. S looks up previous visits under the following: all internal medicine visits this health center by all internal medicine providers over the past two months.*
Ability to easily retrieve the patient medication list.		*Dr. S reviews the current medication list, Dr. S sees Micronase listed.*
Allow clinician to deactivate medications at the time of review.		*Dr. S deactivates the Micronase.*
Indicate notification status e.g. Urgent		*Dr. S receives an urgent telephone call from a patient who is having chest pain at home.*

Utilize a sound search mechanism to assist the user in searching for a patient by name.		*The patient's name is J. Thibeault (te-bo). Mr Thibeault does not know his medical record number so Dr. S retrieves his record using the Soundex function.*
Allow the user quickly access and display another record while leaving previously used record open.		*Dr. S quickly retrieves Mr. Thibeault's online record without having to close the previous patient's record.*

Demonstration, evaluation, and selection

Five finalist commercial clinical information systems were individually evaluated. The ability of each system to provide the defined core functions and attributes was assessed in a demonstration employing the clinical scenarios described above.

Each vendor received the same scenarios coupled with specific instructions that a four hour demonstration be provided which rigidly adhered to the scenarios. Sample medical record data were provided so as to make the comparisons of data presentation easier for the selection team. All vendors received an equal amount of preparation time.

Each requirement was scored using the following scale:

0 = Does Not Meet Requirement
\+ = Partially Meets Requirement
++ = Fully Meets Requirement

The strengths and weaknesses of each system were summarized and compared. Based on the performance in the demonstrations, a CIS was selected for implementation.

DISCUSSION

Effectiveness of the evaluation tool

We found our evaluation tool-- a clinical case study mapped to a requirements document-- to be an effective mechanism for structuring clinician participation in the CIS evaluation process and for comparing different clinical information systems. Providing vendors with identical scenarios and having them demonstrate how their systems would support clinical workflow allowed the selection team to objectively compare functionality among systems. Using this method, we were able to identify strengths and deficiencies that would not have been apparent had the vendors simply demonstrated their systems.

Advantages over traditional evaluation methods

The traditional RFP process is useful for assessing features of a CIS, but may not provide an accurate assessment of the true functionality of a system. Likewise, traditional vendor demonstrations provide an opportunity for vendors to show customers what their systems do best; however, they may not provide an accurate picture of how clinicians will actually use a system or how well a system will fit into an organization. Clinical case studies have been used in the past to compare vendor systems.[7] However, the use of scenarios or case studies does not address the task of comparing systems. Our methodology, mapping detailed requirements to specific elements of clinical scenarios allowed us to create a standard evaluation tool for objectively rating systems and making comparisons between systems.

Clinician support for the evaluation tool

The evaluation tool provided them with the opportunity to determine if, and how, the CIS would support the tasks they most frequently performed, as opposed) viewing attributes of the systems that were technically sophisticated, but relatively unimportant. Although clinical functionality is only one factor involved in the decision to select and implement a CIS, providing a tool which permitted clinicians to participate in the evaluation in an objective manner was important. We found the evaluation process to be useful for presenting the clinical information systems in a way clinicians could interpret and evaluate and for drawing out important clinician feedback. Clincian response to this process has been favorable.

CONCLUSIONS

From our experience, we have concluded that an organization's clinical information systems requirements should reflect the needs of clinicians within the context of clinical practice and workflow. Formalizing these needs using a detailed requirements document, which is linked to specific elements of custom-

ized clinical scenarios, is an effective and efficient way of distinguishing among candidate clinical information systems. This methodology provides the means for objectively evaluating and directly comparing clinical information systems.

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